



# **H- $\gamma\gamma$ : Update on $\gamma$ Efficiency & $\gamma$ /Jet Rejection/Separation**

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# OUTLINE

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- Motivation and Goals
- Neural Nets
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  - ◆ Neural Net Training Variables
  - ◆ Neural Net Results
- Rejection of Gluon Jets
  - ◆ Extended Definitions
- Conclusions & Future Plans



# MOTIVATION & GOALS

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- ◆ Di-jet Rejection with Neural Nets
- ◆ Work in progress on rejection of the following reducible backgrounds (we are using separated samples for better identification)
  - ◆  $q\bar{q} \rightarrow \gamma + g$
  - ◆  $gq \rightarrow \gamma + q$
- ◆ Use rejection parameters in full  $H \rightarrow \gamma\gamma$  analysis.



# NEURAL NET

## Training Details (SNNS)

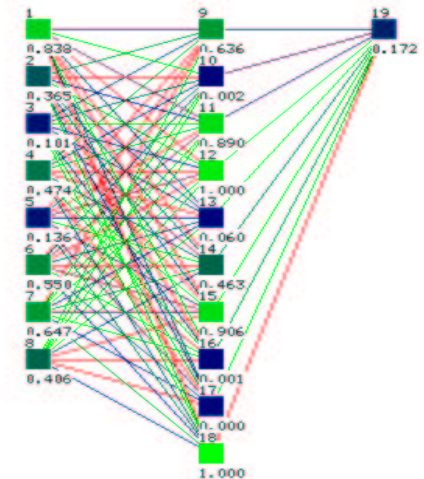
Connectivity: Feed Forward Network/Convergent

Learning Algorithm: Standard Back Propagation

Data Samples Used:  $M_H = 130 \text{ GeV}$  MC@NLO files  
Di-jets  $17 < E_T < 23 \text{ GeV}$

Net Structure:

8 input nodes  
10 hidden nodes  
1 output node





# MC DATA SETS USED

Higgs Events	Number of Events
<b>Higgs-&gt;Gamma Gamma <math>M_h = 120</math> GeV</b>	
002329.lumi02.recon.009.*.hlt.pyt_h120...	10000
<b>Higgs (-&gt;Gamma Gamma) + Jet <math>M_h = 130</math> GeV</b>	
higgs.002638.nlo_h130.dc1.simul...	66455
<b>Di-Jet Events</b>	
<b>17 GeV</b>	
002000.lumi02.recon.010.....hlt.pythia_jet17	251423
<b>25 GeV (to be done)</b>	
dc1.002001.lumi02.recon.009._....hlt.pythia_jet_25.root	116651
<b>55 GeV (to be done)</b>	
dc1.002002.lumi02.recon.009.....hlt.pythia_jet_55.eg9.603.root	237604
<b>Photon-Gluon Jet Events</b>	
<b>20 GeV</b>	
higgs.002655.bg_gamma_g.dc1.recon.001._0*.root	456552

## Luminosity:

$2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$  (approximately 4.6 minimum bias events added per bunch crossing.)

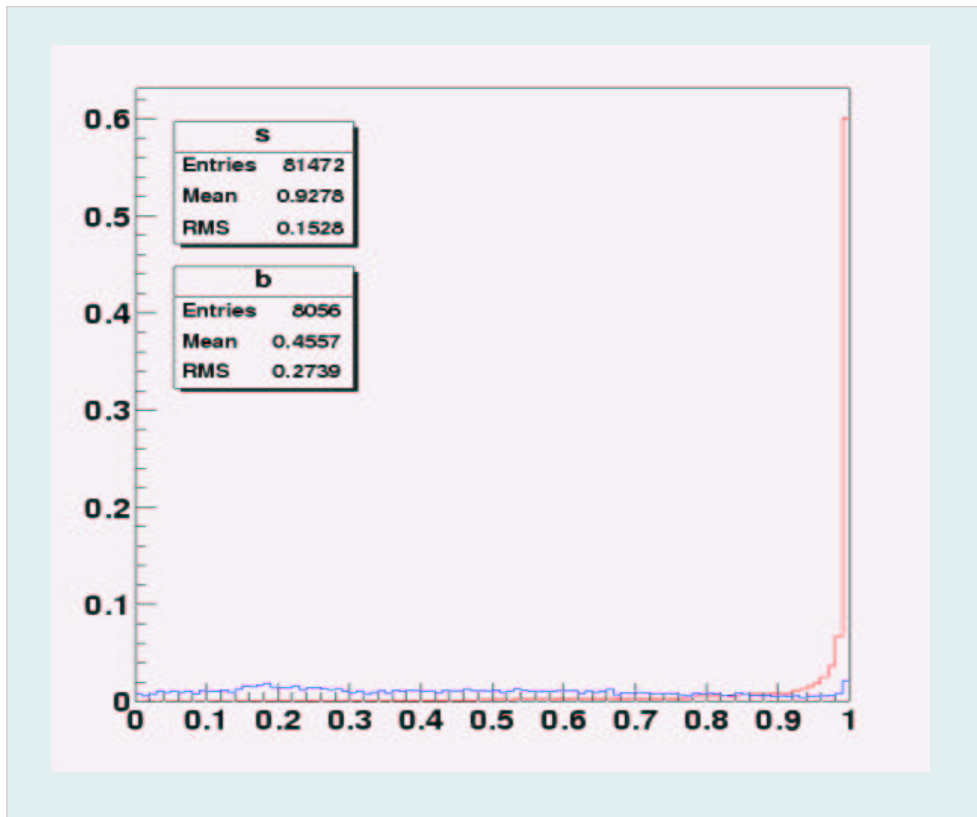


# TRAINING VARIABLES

Preselection Cuts	Photons		$E_{T1} > 40 \text{ GeV} \ \& \ E_{T2} > 25 \text{ GeV}$
	Jets		$E_T > 17 \text{ GeV} \ \& \ \text{LVL1}$
Variables	Hadronic	H	$E_T(\text{Had})/E_T(\text{EM})$
	Second Sampling	2S_a	$E_2(3 \times 7)/E_2(7 \times 7)$
		2S_b	Corrected shower width using $3 \times 5$ cells in $\eta$ .
	First Sampling	1S_a	Energy of strip with maximal energy deposit scaled by fraction of Total $E_T(\text{EM})$
		1S_b	Energy of strip where second maximum is found minus the energy of the valley between the two maxima.
		1S_c	Fraction of energy outside the shower core in $\eta$ .
		1S_d	Corrected shower width using three strips.
		1S_e	Total width in first sampling using 20 strips.



# NEURAL NET Results



Cut value of 0.9 (NN)

Photon Efficiency: 85 %

Jet Rejection : 1712

Cut Analysis (Lots of cuts)

Photon Efficiency: 85 %

Jet Rejection : 1254

**NN Improvement = 27 %**



# Gluon Jets Rejection Studies

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- Need a consistent mechanism to identify gluons coming from the matrix element.
- Need a consistent definition of rejection.
- So far, we have looked at three different methods for tagging the gluon jets (work in progress).



# DEFINITIONS

$$\text{Photon Efficiency} := N_{\text{Accepted Photons}} / N_{\text{Total}}$$

$$\text{Jet Rejection}^* := N_{\text{AtlFAST Jets}} / N_{\text{Accepted Jets}}$$

$$\text{Jet Rejection}^{**} := N_{\text{AtlFASTB Jets}} / N_{\text{Accepted Jets}}$$

$$\text{Jet Rejection}^{***} := N_{\text{MatrixElementGluonJets}} / N_{\text{Accepted Jets}}$$

$N_{\text{ATLFASTJets}}$  is normalized to the number of events prior to the particle level filter.

\* Jet rejection with respect to jets observed in AtlFast ([a.k.a.](#) uncorrected).

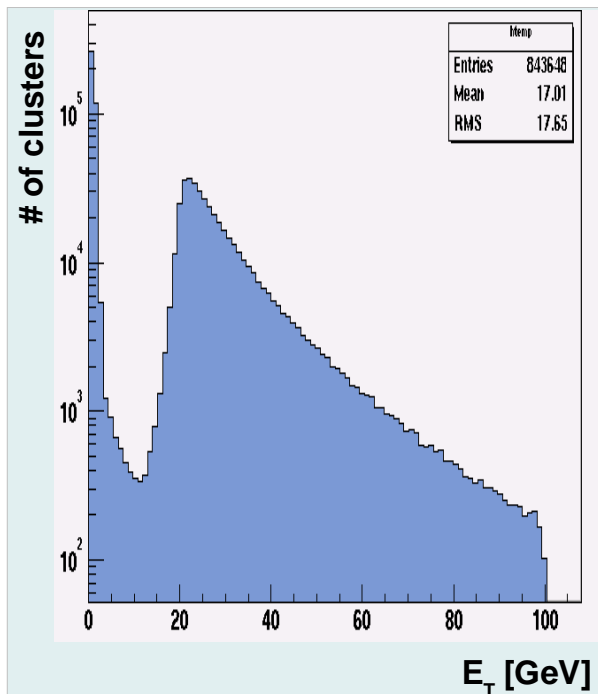
\*\* Jet rejection with respect to jets observed in AtlFastB.

\*\*\* Jet rejection with respect to identified partons (Orsay Group).

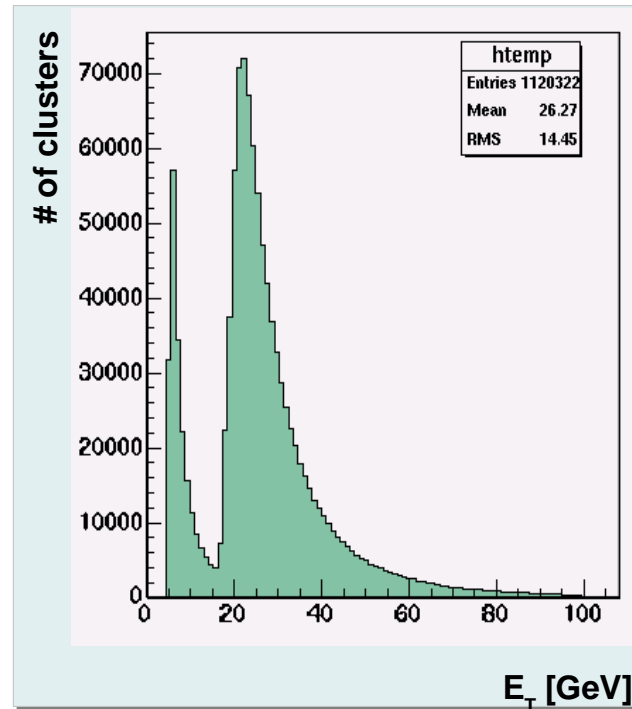


# Control Plots

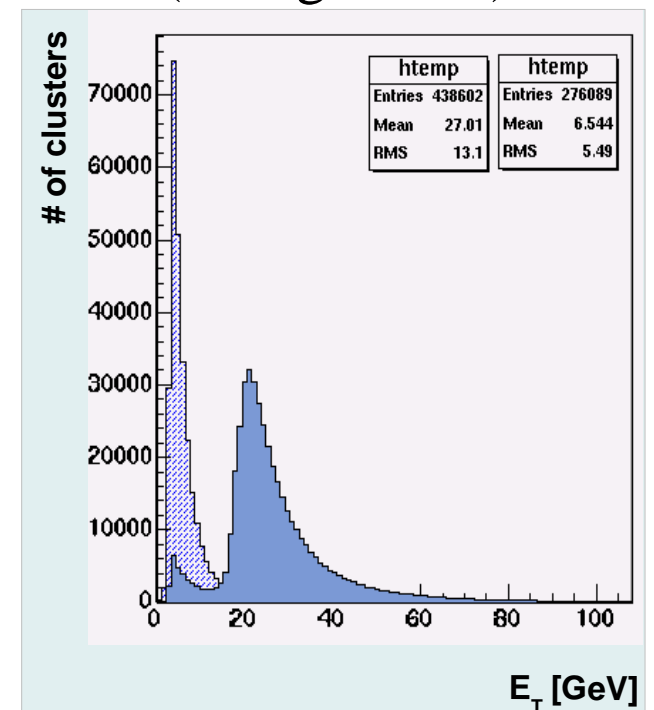
Gluon  $P_T$  from  
Generated Info



Photon  $P_T$  from  
Generated Info

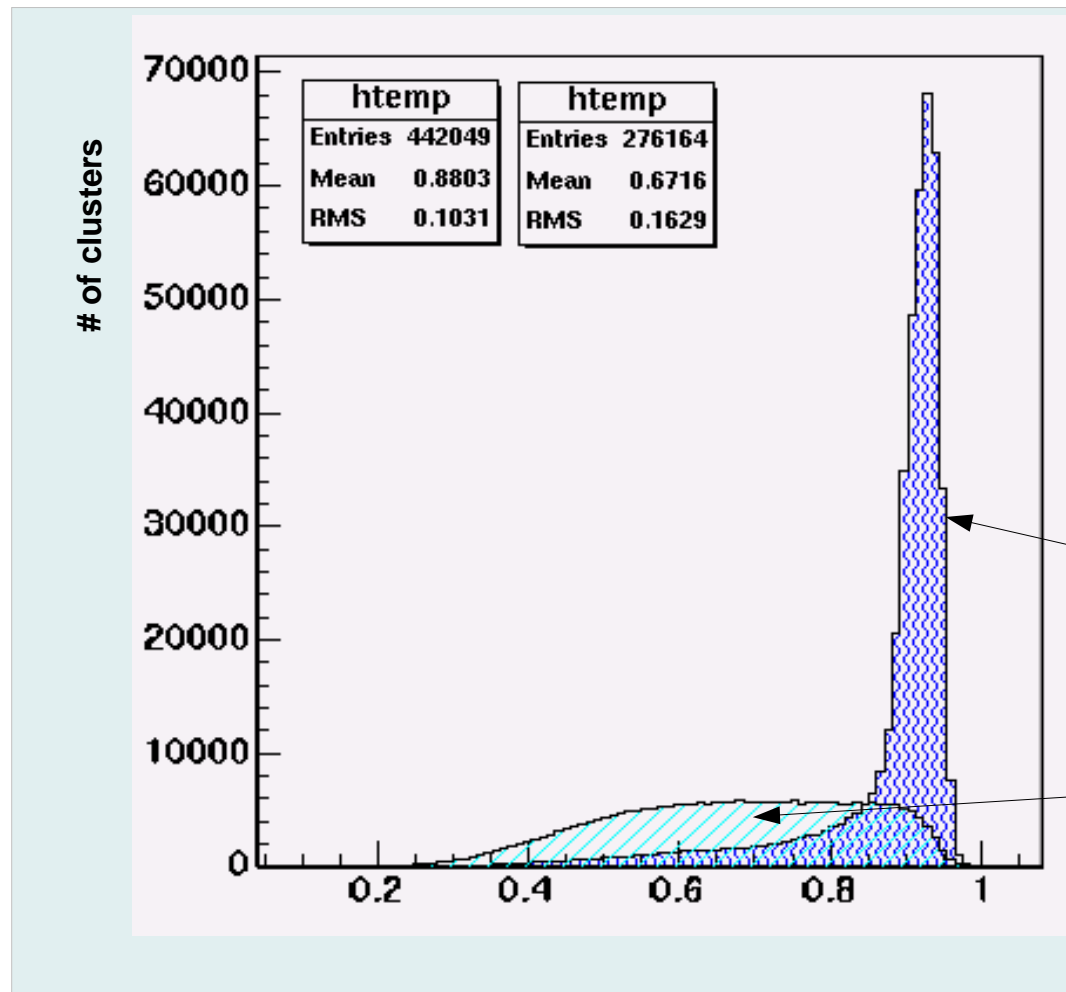


$E_T$  from EM clusters  
(change scale)





## Control Plots (2)



Distribution of Second  
Sampling Variables  
(shower shape)  
eg\_e237/eg\_e277  
for zeroth and first  
clusters.

Zeroth Cluster

First Cluster



## RESULTS & FUTURE PLANS

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- ◆ ~27% improvement on jet rejection using neural networks over cut analysis.
- To study jet rejection in other  $P_T$  regions for di-jets.
- To complete jet rejection studies for reducible backgrounds pertaining to the  $H \rightarrow \gamma\gamma$  analysis.
- To apply existing corrections to photon identification and isolation studies (INFN Milano).